## SOUNDSCAPES

Our ability to see is a powerful tool for experiencing our world, but sound adds a richness that sight alone cannot provide. In many cases, hearing is the only option for experiencing certain aspects of our environment. The symphony of natural sounds within our national parks is an important natural resource and a critical component of the ecological communities that parks seek to preserve. Understanding the role of sound and acoustics in a healthy ecosystem is critical to their effective management and protection (National Park Service, 2011). The human perception of the acoustical environment is referred to as the soundscape. Soundscapes is included as an indicator for the draft Tuolumne River Plan and is also in development as potential indicator for the Merced River corridor.

**Standards in Development:** Soundscape standards for human-caused sound events, measured in "A" frequency weighted decibels "dB(A)" (Vanderheiden, 2011), are in development for use in wilderness and non-wilderness areas during daytime and night time(Table 1). Several soundscape research sites have been selected in both the Tuolumne (Figure 1) and Merced River and acoustic data was collected in 2009 and 2010.

### Introduction

The combination of physical sound resources, or acoustic resources, at a particular location comprises what is known as the acoustical environment. Noise can impact the acoustical environment much like smog impacts the visual environment, and the Noise Control Act (1972) initiated a federal program of regulating noise pollution with the intent of minimizing excessive noise and protecting human health. The National Park Service Organic Act (1916) mandates the preservation and/or restoration of natural resources within parks, including the acoustical environment, or soundscape.

As part of indicator development for natural soundscapes, scientists and managers have investigated loud noise events and hourly change in exposure in Yosemite National Park. The potential 60 dB(A) daytime standard threshold is based on the audio disturbance regulation in the Code of Federal Regulations 36 CFR Section 2.12 (Parks, Forests and Public Property, 1983), which establishes a maximum sound level for motorized equipment of 60 dB(A) at 50 feet (15.24 meters) for all areas of the park. The potential 45 dB(A) night time standard threshold is based on peer-reviewed scientific research on sleep interference (Haralabidis et al., 2008).

Naturally occurring sounds, or a combination of naturally occurring sounds, such as thunder and the roar of a river, can exceed 60 dB(A). Research from the 2009 Annual Report: Visitor Use and Impact Monitoring Program (Yosemite National Park), shows that water is a significant source of sound energy, and water, along with wind can be an effective masking mechanism for anthropogenic sounds in Yosemite National Park.

The hourly change in exposure parameter in development is based on the belief that an increase in sound exposure less than 3 dB(A) is probably not noticeable to visitors, but would reduce their listening horizons, while an increase of 6 dB(A) would clearly be noticeable, and could potentially halve the maximum distance of detection for many natural sounds. Analyzing hourly change in sound levels is

technically challenging; data from the Yosemite National Park Acoustic Monitoring Report 2005 & 2006 (2007), shows significant hourly changes in sound levels, at times exceeding 60 dB(A) for daytime hours.

Road corridors have inherently more frequent occurrences of unnatural sounds and the maximum sound level for human-caused sounds specified in the Code of Federal Regulations remains applicable in road corridors. Minimizing loud sounds in road corridors would help to protect the natural soundscapes in park campgrounds, backcountry areas, etc. Potential strategies for minimizing loud sounds attributed to vehicle use include administrative action to help to control loud vehicles operated by the NPS, and a combination of visitor education and law enforcement to help control loud vehicles operated by park visitors.

**Findings and Highlights**

Table 1 Soundscapes: Parameters, Plan/Application, Standard & Observed Condition

| Parameter | Plan/Application | Standard | Observed Condition |
|---|---|---|---|
| Loud Noise: As measured by human-caused sound events, excluding aircraft noise that is not under NPS control or jurisdiction | Draft Tuolumne River Plan: Daytime, in areas further than 155 feet (47 meters) from the Tioga Rd; Nighttime, in areas further than 797 feet (243 meters) from the Tioga Rd.<br>In development as a potential indicator for the Merced River corridor. | **Wilderness:** *Daytime (0700-2200*), ≤ 60 dB(A); *Nighttime (2200-0700*), ≤ 45 dB(A)<br>**Non-wilderness**: *Daytime (0700-2200*), >60 dB(A) fewer than 5 times per hour on average over a 7-day period; *Nighttime (2200-0700*), >45 dB(A) fewer than 3 times per hour on average over a 7-day period | Data analysis in progress |
| Hourly Change in Exposure: As measured by human-caused sound events, excluding aircraft noise that is not under NPS control or jurisdiction | Draft Tuolumne River Plan: Daytime, in areas further than 155 feet (47 meters) from the Tioga Rd; Nighttime, in areas further than 797 feet (243 meters) from the Tioga Rd.<br>In development as a potential indicator for the Merced River corridor. | **Wilderness:** *Daytime (0700-2200),* hourly change in exposure exceeds 3 dB(A) for no more than 30% of the day and exceeds 6 dB(A) for no more than 10%; *Nighttime (2200-0700)*, ≤ 45 dB(A)<br>**Non-wilderness**: *Daytime (0700-2200*), hourly change in exposure exceeds 3 dB(A) for no more than 60% of the day (i.e. less than 3 dB(A) for at least 40% of the day) and exceeds 6 dB(A) for no more than 10% (i.e. ≤ 6 dB(A) for at least 90; *Nighttime (2200-0700),* hourly change in exposure exceeds 3 dB(A) for no more than 30% of the night and exceeds 6 dB(A) for no more than 5%. | Data analysis in progress |

Data analyses are in progress and will be reported upon as soon as they have been completed.

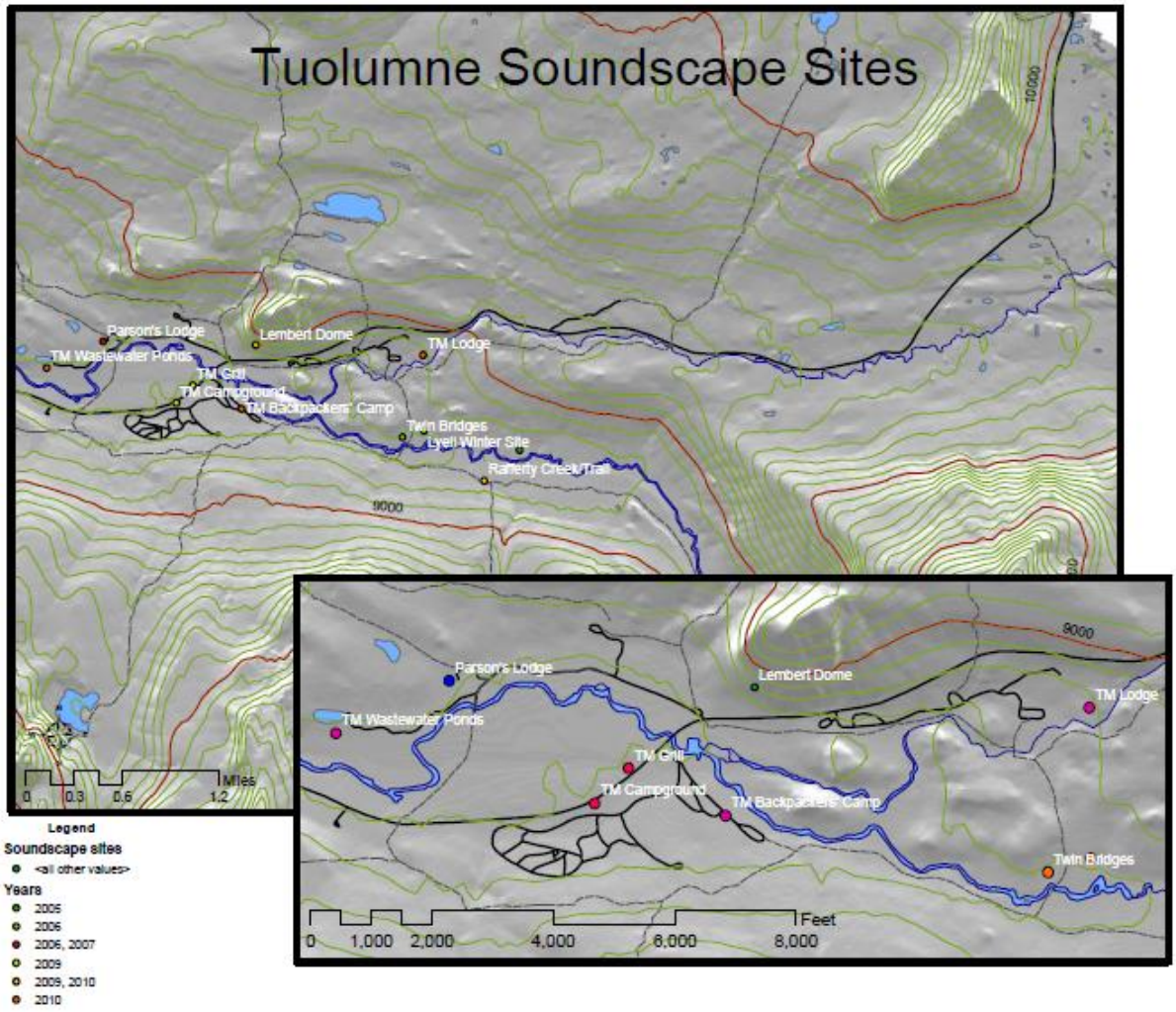


Figure 1 Soundscape Research Sites in the Tuolumne River Corridor: 2006, 2007, 2009 & 2010

**Conclusion & Future Implications**

Analysis of 2009 data in the Tuolumne Meadows campgrounds shows that sound events exceeding 60 dB(A) were largely due to commercial aircraft overflights, with a few loud vehicles such as recreational vehicles and garbage trucks (Yosemite National Park, 2009). Since aircraft are not under the jurisdiction of the NPS and not associated with visitor use, aircraft noise cannot be a factor in determining user capacity; however, aircraft noise does impact the visitor experience, and the NPS will continue to collect and analyze data to evaluate aircraft noise in the context of the proposed standard, and to engage the Federal Aviation Administration to address the issue of aircraft noise (National Park Service, 2011). The 2010 research data will provide a baseline of soundscape conditions, and the methods developed to estimate soundscape attributes at discrete study sites will provide protocols for future soundscape estimation research. Used in conjunction with visitor use data, soundscape research results can be analyzed to understand the relationships between soundscapes and visitor experience across space and time, important contributions to Yosemite's Visitor Use and Impacts Monitoring Program.